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Underreporting of BMI in Adults and Its Effect on Obesity Prevalence Estimations in the Period 1998 to 2001

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Abstract

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Objective: To identify the determinants of underreporting BMI and to evaluate the possibilities of using self-reported data for valid obesity prevalence rate estimations.

Research Methods and Procedures: A cross-sectional monitoring health survey was carried out between 1998 and 2002, and a review of published studies was performed. A total of 1809 men and 1882 women ages 20 to 59 years from The Netherlands were included. Body weight and height were reported and measured. Equations were calculated to estimate individuals' BMI from reported data. These equations and equations from published studies were applied to the present data to evaluate whether using these equations led to valid estimations of the obesity prevalence rate. Also, size of underestimation of obesity prevalence rate was compared between studies.

Results: The prevalence of obesity was underestimated by 26.1% and 30.0% among men and women, respectively, when based on reported data. The most important determinant of underreporting BMI was a high BMI. When equations to calculate individuals' BMI from reported data were used, the obesity prevalence rate was still underestimated by 12.9% and 8.1% of the "true" obesity prevalence rate among men and women, respectively. The degree of underestimating the obesity prevalence was inconsistent across studies. Applying equations from published studies to the present data led to estimations of the obesity prevalence varying from a 7% overestimation to a 74% underestimation.

Discussion: Valuable efforts for monitoring and evaluating prevention and treatment studies require direct measurements of body weight and height.

Key words: bias, epidemiology, misclassification, underestimation, survey

Introduction

The prevalence of obesity is increasing in many parts of the world, and its impact on the public health and on individuals is widely accepted (1,2). Currently, a large number of epidemiological studies are being published in which prevalence estimations of obesity are reported and in which obesity is linked to several health outcomes. Large-scale studies regarding BMI levels are often based on self-reported body weight and height. Use of self-reported weight and height could lead to underestimations of obesity prevalence rates because subjects tend to underreport their body weight (3–8) [especially the obese (9–17)], and subjects tend to overreport body height (4–11,18,19). However, the severity of underreporting has been questioned (19–21), and some authors argue that mean levels of BMI may be estimated relatively well by use of self-reported data.

The most important determinant of underreporting body weight seems to be a high true body weight, and subgroups have been mentioned in the literature that underreport weight or overreport height more than others. High educational level, older age (5,9,10,19), smoking (14,22), female gender (6,19), diabetic status (22), and a digit preference (9,15), i.e., rounding off to values ending with 0 or 5, have been identified as potential determinants for underreporting body weight, although some studies find opposite associations.

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In a few studies, linear regression equations were calculated by which true obesity prevalence rates could be estimated from reported body weight and height (9,11–13,22,23). Some of these linear regression equations were concluded to be valid within the sample from which the linear regression equation was formulated (11,13,22). One study [National Health and Nutrition Examination Study II (NHANES II)] developed linear regression equations from one-half of the sample to test whether the equations were valid in the other one-half of the sample and concluded that self-reported BMI is difficult or impossible to correct by the use of such equations (23). To the best of our knowledge, no attempts have been made to evaluate the validity of linear regression equations across populations. The present study aims to identify the determinants of underreporting body weight and BMI and to evaluate the possibilities of correcting reported body weight and height, based on both the present and published studies.

Research Methods and Procedures

Subjects

We used data from a Dutch population study in which both measured and self-reported data on body weight and height were available. A total of 9499 men and 10,045 women, ages 12 years and older, took part in the Health Interview Survey between January 1998 and December 2001, performed by Statistics Netherlands. Body weight and height were among a series of health- and health behavior-related questions (participation rate, 56.1%). At the end of the Health Interview, participants were asked to participate in the Health Examination Survey of the Risk Factors and Health (REGENBOOG) project. This health examination survey, carried out by the National Institute for Public Health and the Environment in cooperation with Dutch municipal health centers, included measurements of body weight and height (participation rate, 59%). A total of 2737 men and 2672 women participated in both the Health Examination Survey and Health Interview survey. For the purpose of the present study, 1824 men and 1916 women who were 20 to 59 years of age were eligible. Participants younger than 20 years of age and those 60 years or older were excluded. Interpretation of BMI is different at younger and older ages (24,25), and participation rates were very low in these age categories. A total of 13 men and 32 women had a missing value on body weight or height. Two additional subjects who reported a body height of below 1.20 m and two subjects who reported a body weight of 140 kg or higher, with measured body weight below 80 kg, were excluded, leaving in the analyses 1809 men and 1882 women who took part in both the Health Examination Survey and the Health Information Survey with complete data on body weight and height. Seven men and 5 women had a missing value regarding educational level, and 53 men and 42 women had a missing value on smoking.

Measures

Data collection was distributed evenly over the year to take into account potential seasonal effects on body weight (26). Body weight and height were self-reported, and measurements of body weight and height were taken within 3 months after self-report of body weight and height. Body weight (in kilograms) and height (in meters) were reported in the National Interview Survey by use of a routine national health interview survey conducted by Statistics Netherlands. In the present study, these measurements are referred to as "reported" body weight and height. The participants were visited at home, and the interviews were conducted face-to-face by a trained, computer-assisted personal interviewer. After they had reported their body weight and height, participants were subsequently asked to participate in a large health examination. During the health examinations at the local municipal health center, body weight and height were measured by trained staff with participants wearing light indoor clothing with emptied pockets and no shoes. In the present study, these measurements are referred to as measured body weight and height. Body weight was measured to the nearest 100 grams on calibrated scales. To adjust for the weight of clothing, 1 kg was subtracted from the measured body weight. BMI was calculated as weight divided by height squared (kg/m^2). Overweight was defined as BMI $\geq$ 25 kg/m^2, moderate overweight as BMI 25 to 29.9 kg/m^2, and severe overweight or obesity as BMI $\geq$ 30 kg/m^2, according to the World Health Organization criteria. Education was measured as the highest level reached and then categorized in five groups: primary school, junior (vocational) education, secondary (vocational) education, high vocational education, and university. Smoking was recorded as never, ex, and current cigarette smoking. A total of 53 subjects answered yes to the question: Do you have diabetes? regardless of whether they were reporting type 1 or type 2 diabetes. For the purpose of the present study, the 368 subjects with a missing value on this item were regarded as non-diabetic.

In preparing the study, we noted that a substantial part of reported body weight was reported as a multiple of 5 kg (e.g., 65, 70, 75 etc.), as had also been reported in earlier studies (9,15). For the purpose of this study, we defined this as "digit preference." The terminology "true" is used for measures and estimates that are calculated from measured body weight and height.

Statistical Analyses

Mean body weight, height, and BMI were calculated with 95% confidence intervals (CIs)[1] based on measured and reported data, and differences between means and prevalence rates based on reported and measured data were calculated. In addition, means and prevalence data based on measured data were also standardized to the 5-year age distribution in The Netherlands in the year 2000 (27).

The number of subjects reporting their own weight within 5% and 10% of their measured body weight was calculated. Pearson correlation coefficients were calculated between measured and reported body weight, height, and BMI. Underreporting was calculated as the difference between reported and measured data within individuals. Categories of measured body weight, body height, and BMI, and age, educational level, and smoking status were studied as potential determinants of underreporting body weight and BMI by linear regression analyses, and *p* values for trend in underreporting across these categories were calculated (Proc GLM, SAS version 6.12; SAS Institute, Cary, NC).

To estimate individuals' BMI from reported data, equations were calculated by use of the least square linear regression method. We evaluated whether applying these equations led to valid estimations of the mean BMI and prevalence rate of obesity.

Analyses of Published Studies

Earlier studies in adult populations in which obesity prevalence estimations were based on both self-reported and measured data were identified from the literature (from PubMed database and from references in selected studies). Prevalence estimations based on reported and measured data from these surveys were compared (4,6, 8,10,11,14,15,19,22,28) to assess whether a correction factor could be formulated to calculate the true obesity prevalence from reported prevalence rates. In addition, equations from earlier studies (9,11–13,16,19,22) were applied to our data on individually reported body weight and height to evaluate whether using these equations led to similar mean levels of BMI and obesity prevalence estimations. If studies reported equations to calculate weight and height separately, besides equations to calculate BMI, both equations were applied. To apply the equations to the same subjects, subjects without missing values on any of the variables mentioned in the equations were selected.

Results

Table 1 shows that mean body weight was 1.0 and 1.4 kg lower when based on reported data than when based on measured data among men and women, respectively. Most subjects reported a body weight within 10% of their measured body weight (~97% of the men and 95% of the women). Approximately 80% of the men and 77% of the women reported a body weight within 5% of their measured body weight (data not shown). Mean body height was 0.5 and 0.6 cm higher and mean BMI was 0.4 and 0.6 kg/m^2 lower among men and women, respectively, when based on self-reported data (Table 1). Correlation coefficients for measured and reported values of body weight, height, and BMI were 0.96, 0.95, and 0.93, respectively, among men and 0.97, 0.94, and 0.95 among women. Among obese men, correlation coefficients for measured and reported body weight, height, and BMI were 0.91, 0.96, and 0.76, respectively; among obese women, the correlation coefficients were 0.93, 0.92, and 0.88, respectively.

Both the prevalence of overweight and obesity were underestimated when based on self-reported body weight and height (Table 1). The prevalence of obesity was 3.0% and 3.3% lower among men and women, respectively, when based on self-reported data. Thus, as a percentage of the measured prevalence of obesity, obesity was underestimated by 26.1% among men and by 30.0% among women when based on reported data (Table 1).

Underreporting of body weight varied more with measured body weight and BMI than with measured body height, age, educational category, smoking, or reporting weight with a digit preference (data not shown). Underreporting body weight showed a clear dose-response relation with larger values of measured body weight and BMI. Men with body weight < 75 kg or BMI < 23 kg/m^2 and women with body weight < 60 kg or BMI < 20 kg/m^2 overreported body weight. Among obese men and women, mean body weight was 3.9 and 4.2 kg lower, respectively, when based on reported data than when based on measured data (Table 2). Small body height in women and old age were slightly associated with underreporting body weight and BMI. Educational level and smoking were not clearly related to underreporting. A digit preference was associated with underreporting among women, but not among men (data not shown).

Table 3 shows the linear regression equations that we used to calculate individuals' BMI from reported data. Mean BMI was calculated correctly by use of equation 1 for men and women. Among men and women, the prevalence of obesity was 1.6% and 1.0% lower when based on an equation with reported BMI, compared with the obesity prevalence rate calculated from measured data (i.e., 13.8% and 9.0% of the true obesity prevalence rate). When educational level, age, reporting weight with a digit preference, and smoking status were added to the equations, obesity prevalence rates were still underestimated by 12.9% and 8.1% among men and women, respectively (Table 3).

[1] Nonstandard abbreviation: CI, confidence interval.

Table 1. Means and prevalence rates (with 95% confidence limits) among Dutch men and women, ages 20 to 59 years, who had both measured and reported data in the period 1998 to 2002

	Age-standardized*	Measured	Reported	Difference†
Men (n = 1809)				
Weight (kg)	83.9	84.5 (83.9 to 85.1)	83.5 (83.0 to 84.1)	1.0 (0.2; 1.8)
Height (cm)	181.4	180.8 (180.5 to 181.2)	181.3 (181.0 to 181.6)	−0.5 (−1.0; 0.0)
BMI (kg/m^2)	25.5	25.8 (25.6 to 26.0)	25.4 (25.2 to 25.6)	0.4 (0.2; 0.6)
Overweight (%)	54.0	58.0 (55.8 to 60.3)	51.8 (49.5 to 54.1)	6.2 (4.6; 7.8)
Moderate overweight (%)	43.5	46.6 (44.2 to 48.8)	43.3 (41.0 to 45.6)	3.3 (1.4; 5.2)
Obesity (%)	10.4	11.5 (10.0 to 13.0)	8.5 (7.2 to 9.8)	3.0 (2.0; 4.0)
Women (n = 1882)				
Weight (kg)	69.6	70.1 (69.5 to 70.7)	68.7 (68.2 to 69.3)	1.4 (0.6; 2.2)
Height (cm)	168.2	167.8 (167.5 to 168.1)	168.4 (1.68.0 to 168.7)	−0.6 (−1.0; −0.2)
BMI (kg/m^2)	24.6	24.9 (24.7 to 25.1)	24.3 (24.1 to 24.4)	0.6 (0.3; 0.9)
Overweight (%)	38.6	41.5 (39.3 to 43.7)	35.5 (33.3 to 37.7)	6.0 (4.6; 7.4)
Moderate overweight (%)	28.5	30.5 (28.4 to 32.5)	27.8 (25.8 to 29.8)	2.7 (1.0; 4.3)
Obesity (%)	10.1	11.0 (9.6 to 12.5)	7.7 (6.5 to 8.9)	3.3 (2.5; 4.2)

Positive values reflect underestimations, and negative values reflect overestimations of means or prevalence rates.
* Standardized to the 5-year age distribution in the Netherlands in the year 2000, based on measured data.
† Difference in means and prevalence rates based on measured and reported data.

Published Studies

The variance among studies in difference between measured and reported obesity prevalence rates is large, varying from 0.0% to 49.6% as percentage of the true obesity prevalence rate (Figure 1). In one study, where underestimation of obesity was nearly absent, the questionnaire to report body weight was sent out 2 weeks before the clinic appointment date (22). Any consistency between the obesity prevalence estimation based on reported data and the size of underestimation could not be detected.

Table 2. Means and prevalence rates (with 95% confidence limits) among obese* subjects

	Measured	Reported	Difference†
Obese men (n = 182)			
Body weight (kg)	106.3 (104.7; 107.9)	102.4 (100.0; 103.9)	3.9 (1.7; 6.1)
Body height (cm)	180.3 (179.3; 181.3)	181.0 (179.9; 182.1)	−0.7 (−2.2; 0.8)
BMI (kg/m^2)	32.7 (32.4; 33.0)	31.2 (30.9; 31.5)	1.5 (1.0; 2.0)
Obesity (%)	All	65.9 (59.4; 72.3)	34.1 (27.7; 40.6)
Obese women (n = 196)			
Body weight (kg)	93.5 (91.7; 95.3)	89.3 (87.6; 91.0)	4.2 (1.8; 6.6)
Body height (cm)	166.4 (165.6; 167.2)	167.4 (166.5; 167.2)	−1.0 (−2.2; 0.2)
BMI (kg/m^2)	33.8 (33.2; 34.4)	31.9 (31.4; 32.4)	1.9 (1.1; 2.7)
Obesity (%)	All	65.9 (59.5; 72.2)	34.1 (27.8; 40.5)

Positive values reflect underestimations, and negative values reflect overestimations of means or prevalence rates.
* BMI $\geq$ 30 kg/m^2 based on measured body weight and height.
† Difference in means and prevalence rates based on measured and reported data.

Table 3. Mean BMI and prevalence of obesity as calculated from equations that were calculated from the present data applied at individually reported data

	Mean BMI (kg/m^2)	Obesity (%)
Men (n = 1749*), calculated by use of measured values	25.8	11.6
Equation 1-A: $-0.1120 + 1.0212 \times$ reported BMI	25.8	10.0
Equation 1-B: $-0.6471 + 1.0155 \times$ reported BMI $+ 0.0488 \times$ education $+ 0.0100 \times$ age $+ 0.0428 \times$ rounding $+ 0.0288 \times$ smoking	25.8	10.1
Women (n = 1835*), calculated by use of measured values	24.9	11.1
Equation 2-A: $-0.7041 + 1.0561 \times$ reported BMI	24.9	10.1
Equation 2-B: $-0.7253 + 1.0469 \times$ reported BMI $- 0.0358 \times$ education $+ 0.0043 \times$ age $+0.2940 \times$ rounding $+ 0.0397 \times$ smoking	24.9	10.2

* Subjects with missing values on educational level or smoking were excluded from these analyses.
Education was classified as 1 to 5 for the five categories, rounding as reporting body weight as a multiple of 5 kg (0, no; 1, yes) and smoking (1, current; 2, ex; 3, never smoker).

Table 4 shows equations to calculate individual levels of BMI from reported data that were presented earlier by other authors. Applying these equations to our individual levels of reported data led to different calculations of the mean BMI, varying from 24.7 to 26.2 kg/m^2, and to different calculations of the obesity prevalence, varying from 4.5% to 12.4% (i.e., a 7% overestimation to a 61% underestimation as a percentage of the true obesity prevalence). Among women, calculations of the mean BMI varied from to 22.5 to 25.2 kg/m^2, and calculations of the obesity prevalence among women varied from 2.9% to 11.4% (i.e., a 3% overestimation to a 74% underestimation as a percentage of the true obesity prevalence) (Table 4). Characteristics of studies presented in Figure 1 and Table 4 are listed in Table 5.

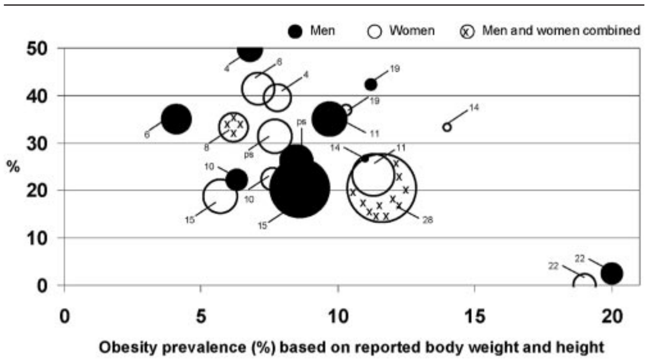

Figure 1: Underestimation of obesity prevalence rates as a percentage of the true obesity prevalence rate in various studies. Larger data points represent larger studies. Numbers denote references. ps, present study.

Discussion

The true prevalence of obesity was underestimated more severely than the true mean BMI, when reported body weight and height were used, partly because underreporting body weight occurred mostly in the obese. Although individual rates of underreporting were small, on average, obesity was underestimated by 26.1% in men and by 30.0% in women as a percentage of the true obesity prevalence. Linear regression equations that we calculated from the current study led to accurate estimations of the mean BMI, but the obesity prevalence was still underestimated when using these equations, by 12.9% and 8.1% of the true obesity prevalence rate among men and women, respectively.

Comparing published studies confirmed that reported body weight and height cannot substitute for measured body weight and height when estimating obesity prevalence for the following reasons: 1) Variation in underestimation of obesity prevalence by use of reported data is large and inconsistent. Thus, it appears to be unfeasible to produce a correction factor that allows the estimation of true obesity prevalence from a reported prevalence rate. 2) It is also inappropriate to use equations to calculate individuals' BMI from their reported data. Equations may be appropriate for the estimation of mean body weight and in some studies for

Table 4. Mean BMI and prevalence of obesity as calculated from equations published in earlier studies applied at individually reported data from the present study

Reference	Equation	Mean BMI (kg/m^2)	Obesity (%)
Men (n = 1749*), based on measured data:		25.8	11.6
9	Height (m) = (7.1987 + 0.8865 self-reported height (inches) + 0.022 × age − 0.0004 × age^2) × 0.0254 Weight (kg) = (−4.1259 + 1.0185 × SRW (pounds) × 0.4536	25.8	10.4
11	Height = 15.302 + 0.923 × self-reported height − 0.052 × age Weight = 0.561 + 1.012 × SRW + 0.006 × age	26.2	12.4
11	BMI = 0.145 + 0.996 × self-reported BMI + 0.017 × age	26.2	11.5
12†	Height = 16.90 + 0.907 × self-reported height Weight = 8.85 + 0.872 × SRW	24.8	5.0
12†	BMI = 3.30 + 0.848 × self-reported BMI	24.8	4.5
16	Height (m) = [4.89 + 0.93 × self-reported height (inches)] × 0.0254 Weight (kg) = [−3.79 + 1.03 × SRW (pounds)] × 0.4536	25.7	10.1
19	Height = 19.90 + 0.90 × self-reported height Weight = 3.96 + 0.95 × SRW	24.9	5.8
	BMI = 2.60 + 0.87 × self-reported BMI	24.7	4.5
22	Height = 22.120 + 0.880 × self-reported height − 0.0435 × age + 0.0217 × SRW Weight = 2.485 + 0.979 × SRW − 0.7086 (current smoker) + 0.0993 (ex-smoker) + 1.4034 (diabetic)	25.4	7.7
13†	Height = 16.7 + 0.89 × self-reported height + 0.037 × SRW Weight = 4.2 + 0.94 × SRW	25.2	6.1
13†	BMI = 2.292 + 0.893 × self-reported BMI	25.0	5.3
Women (n = 1835*), based on measured data:		24.9	11.1
9	Height (m) = [7.4583 + 0.8745 × self-reported height (inches) + 0.0424 × age − 0.0007 × age^2] × 0.0254 Weight (kg) = [−3.1974 + 1.0438 × SRW (pounds) − 0.0175 × age] × 0.4536	25.0	10.4
11	Height = 27.096 + 0.853 × self-reported height − 0.069 × age Weight = 0.444 + 1.010 × SRW + 0.006 × age	24.9	9.4
11	BMI = −0.631 + 1.008 × self-reported BMI + 0.022 × age	24.8	9.5
12‡	Height = 22.92 + 0.886 × self-reported height Weight = 6.72 + 0.87 × SRW	22.5	2.9
12‡	BMI = 3.21 + 0.830 × self-reported BMI	23.4	4.0
16	Height (m) = [4.10 + 0.94 × self-reported height (inches)] × 0.0254 Weight (kg) = [−8.80 + 1.10 × SRW (pounds)] × 0.4536	25.2	11.4
19	Height = 37.97 + 0.77 × self-reported height Weight = 7.46 + 0.87 × SRW	24.0	5.4
	BMI = 5.57 + 0.74 × self-reported BMI	23.5	3.1

Table 4. Continued

Reference	Equation	Mean BMI (kg/m^2)	Obesity (%)
22	Height = 18.684 + 0.900 × self-reported height − 0.0422 × age + 0.0101 × SRW	24.4	7.6
	Weight = 0.8759 + 1.0006 × SRW		
13†‡	Height = self-reported height + 0.033 × age	23.3	5.1
	Weight = 0.95 × SRW + 0.041 × age		
13†‡	BMI = 1.835 + 0.893 × self-reported BMI	23.5	5.1

SRW, self-reported weight.

* Subjects with missing values on educational level or smoking were excluded from these analyses.

† All studies presented were surveys, except the study by Kuskowska-Wolk (13), who studied patients who came to the hospital for a medical appointment.

‡ Among women, obesity was defined as BMI > 28.6 kg/m^2 in the Kuskowksa-Wolk (12,13) studies.

the estimation of the obesity prevalence rate in the same populations from which equations were calculated, but such equations should not be used across populations. It would be coincidental if the population of one's interest would be similar to the population of one of the few studies presenting equations. The most important barrier in making an appropriate choice for a suggested equation is that the strongest determinant of underreporting is unknown, namely true body weight.

Measured body weight was the most important determinant of underreporting body weight. High age and reporting weight with a digit preference in women were also slightly associated with misreporting, but adding these issues into the equation for calculating "true" BMI together with educational level and smoking did not improve our estimations of the obesity prevalence rate. Subjects older than 60 years tend to overreport their body height when their body height has declined since their last measurement (5,9,13). A relatively high level of education is a potentially more important determinant for underreporting body weight in women than in men because thinness may be more desirable in highly educated women (3,15). A digit preference when reporting body weight was slightly more common in obese than in non-obese subjects. Obese women rounded their weights to the lower 5 kg rather than to the higher 5 kg. A history of dieting and degree of restrained eating has been reported as determinants of underreporting (3,20,29).

Frequent weighing, at least once per month, is reported to lead to more accurate reporting of body weight (14). Although we do not conclude that self-reported body weight and height may be valid alternatives to measuring body weight and height, it seems advisable to ask subjects to weigh themselves before they report their body weight and height in an interview or questionnaire. Spencer et al. (11) hypothesized that an alternative may be to measure at least a few subjects per quantile of the BMI distribution.

Use of self-reported data is of concern in large monitoring studies that are often meant to be nationally representative. For instance, from two representative studies from the United States, it has been reported that the obesity prevalence rate was 20.9% when based on reported data from a telephone survey (30) and 30.5% when based on measured data from a health examination (31). It is also possible that selective participation affected these differences. Consequently, population-based fractions of obesity-related consequences will be underestimated when based on obesity prevalence rates that are based on reported data. With an assumed relative risk of obesity for coronary heart disease of 2.5 (32), the fraction of coronary heart disease attributable to obesity would be 24% when based on reported data and 31% when based on measured data. Besides general underestimations of the obesity prevalence, Boström et al. (6) noted that wrong conclusions could be drawn regarding socioeconomic differences in obesity when differences are studied on the basis of self-reported data. If underestimation of body weight is higher in those with a high educational level, the social gradient in obesity prevalence rates will be overestimated with the use of reported data. Also of methodological concern is the use of reported body weight in epidemiological studies linking body weight to health outcomes. Specific underreporting in the obese may lead to an attenuation of relationships between obesity and health outcome measures. The relation between obesity and asthma, for instance, was attenuated when BMI was reported rather than measured (33). Odds ratios of obesity for asthma were 2.5 (95% CI, 1.1 to 5.9) and 2.3 (95% CI, 1.5 to 3.8) among men and women, respectively, when obesity status was defined on the basis of measured body

Table 5. Characteristics of studies presented in Table 4 and Figure 1

First author	Number of men	Number of women	Age	Period between health interview and examination	Obesity prevalence: Men, Measured	Obesity prevalence: Men, Reported	Obesity prevalence: Women, Measured	Obesity prevalence: Women, Reported
Alvarez-Torices (19)	222	203	≥18	N.p.	19.4	11.2	16.3	10.3
Bolton-Smith (22)	765	860	25 to 64	<2 Weeks	20.5	20.0	19.0	19.0
Boström (6)	1440	1768	18 to 84	4 to 6 Months	6.3	4.1	12.1	7.1
Flood (14)	94	133	16 to 85	0 to 6 Months	15.0	11.0	21.0	14.0
Hill (4)	1007	1251	16 to 64	1 to 4 Months	13.5	6.8	12.9	7.8
Kuskowska-Wolk (13)*†	119	182	16 to 84	Same day	14.3	10.1	13.2	11.5
Kuskowska-Wolk (12)*	1890	1500	18 to 84	4 to 6 Months	6.6	N.p.	12.5	N.p.
Niedhammer (15)	5342	1845	35 to 50	<6 Months	10.8	8.6	7.0	5.7
Nieto-García (28)‡	3507	3948	20 to 79	Same day	14.6	11.6	14.6	11.6
Pirie (16)	1608	1799	20 to 59	<1 Month	N.p.	N.p.	N.p.	N.p.
Roberts (10)	806	816	18 to 64	3 to 8 Months	8.1	6.3	9.8	7.6
Rowland (9)§	5396	5888	20 to 74	Few weeks	8.2	N.p.	11.6	N.p.
Spencer (11)	1870	2938	35 to 76	Few weeks	14.9	9.7	14.7	11.3
Stewart (8)‡	955	518	35 to 65	N.p.	9.3	6.2	9.3	6.2
Visscher (ps)	1809	1882	20 to 59	<3 Months	11.5	8.5	11.0	7.7

N.p., not presented; ps, present study.
* Among women, obesity was defined as BMI > 28.6 kg/m^2 in the Kuskowksa-Wolk (12,13) study.
† All studies presented were surveys, except the study by Kuskowska-Wolk (13), who studied patients who came to the hospital for a medical appointment.
‡ Men and women were combined in the analyses by Nieto-García and Stewart (28).
§ Obesity in the Rowland study was defined as BMI ≥ 31.1 for men and as BMI ≥ 32.3 for women.

weight and height and were only 1.7 (95% CI, 1.1 to 2.7) and 1.3 (95% CI, 0.6 to 2.9) when obesity was defined on the basis of reported body weight and height (33). Furthermore, use of reported body weight and height was inappropriate for estimating individuals' obesity status. For obese men and women, based on measured body weight and height, body weight was underreported by 3.9 and 4.2 kg, respectively. Thus, 34.1% of the obese men and women would not have been identified as obese when based on self-reported body weight and height. It has been argued that using self-reported data as inclusion criteria for obese subjects in, for instance, weight loss studies may lead to selection bias of study participants (18,34). Sensitivity to detect obesity may decrease with older age (28).

Although reported data do lead to underestimations of the obesity prevalence, reported data may lead to smaller biases when estimations of increases in obesity are studied on a yearly basis. In The Netherlands, the time trends in obesity have been similar when based on measured data (35) and when based on reported data (36). Flood et al. (14) concluded that periodic sub-studies of the validity of self-reported data are needed to indicate the extent to which the bias of self-reported data is changing over time.

Time delay between reporting and measuring body weight could be 4 to 6 months in referenced studies (4,6, 10,12,14,15), and it has been argued that body weight and height could change dramatically in such a period, especially in younger subjects (37). We propose that body height will not change in adults in such short periods, and mean changes in weight are usually small and could not explain large values of underreporting obesity. The studies that are compared in the present study were all performed in adults. Age ranges and educational status were similar, but not identical, in the various studies. It should be noted that age and educational status were not important determinants of underreporting body weight. It is more relevant to monitor obesity prevalence than the mean values of BMI, as the prevalence of obesity is increasing more rapidly over time than the mean BMI (35,38).

Conclusions

The use of reported body weight and body height could lead to bias in estimating obesity prevalence in a population or an individual's obesity status. Measuring body weight and height is costly and time-consuming, but valuable efforts for monitoring and evaluating prevention and treatment studies do require direct measurements of body weight and height.

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